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METHOD AND APPARATUS FOR PROVIDING TACTILE SENSATIONS

CROSS-REFERENCES TO RELATED APPLICATION

This application is a continuation of co-pending U.S. patent application Ser. No. 12/894,489, entitled "Method and Apparatus for Providing Tactile Sensations," which is a continuation of U.S. patent application Ser. No. 11/693,117, filed Mar. 29, 2007, now U.S. Pat. No. 7,808,488, issued Oct. 5, 2010, entitled "Method and Apparatus for Providing Tactile Sensations," which is a continuation of U.S. patent application Ser. No. 10/285,450 filed Nov. 1, 2002, now U.S. Pat. No. 7,336,260, issued Feb. 26, 2008, entitled "Method and Apparatus for Providing Tactile Sensations", which claims priority to U.S. Provisional Application No. 60/335,493, filed Nov. 1, 2001, and U.S. Provisional Application No. 60/399,883, filed Jul. 31, 2002, the entirety of all of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to methods and apparatus for providing tactile sensations.

BACKGROUND

Conventional electronic devices, such as mobile telephones and Personal Digital Assistants (PDAs), include visual displays. A user of such devices interacts with the visual display using any one of a number of input devices. Examples of such input devices include computer mice, joysticks, trackballs, steering wheels, stylus, tablets, pressure-sensitive spheres, scroll wheels, keyboards, and keypads. The user provides instructions, responses, and other input to the device using such input devices.

In conventional mobile telephones and PDAs, confirmation of the input provided by the user is primarily limited to visual or audible confirmation. In some such devices, physical feedback is provided by conventional mechanical switches in the form of the conventional mechanical feedback of switches, for example the switch closure force-displacement profile. Typically, in such devices, the mechanical feedback provided by each button is identical. In addition, in such conventional devices, for those buttons that serve multiple functions, the mechanical feedback generally remains the same regardless of the current function of the button.

In addition to providing extremely limited and rudimentary mechanical confirmation of button selection, conventional buttons as used, for example, in keypads for mobile telephones and PDAs, provide simple passive touch cues regarding the alignment of keys. Such cues include raised bumps on the center key of a telephone keypad or on the "F" and "G" keys of a keyboard that assist a user in orienting to the pattern of keys in the keypad and keyboard. Again, these physical queues are very limited, and users typically need to view a keypad or keypad for visual confirmation that the correct instructions or information is being entered.

When a flat surface interface device is used, such as a touchpad for a computer or PDA, these simple mechanical cues are unavailable to the user. Often, touchpads are combined with flat-panel display screens that display one or more graphically generated buttons or softkeys. Normally, the softkeys are visible through the touchpad. A user's contact with

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the touchpad in an area defined by a softkey provides the electronic device having the touchpad with the input associated with that softkey.

The use of electronic devices using such conventional mechanical buttons and touchpad arrangements are particularly difficult to use in distracting environments or when the user is attempting to perform another task simultaneously with using the electronic device. For example, if the other task involves operating a motor vehicle or heavy machinery, it may be difficult or impossible for a user to simultaneously use such an electronic device because such devices typically require the user to look at the device, at least briefly, when interacting with the device. In addition, electronic devices relying on softkeys can be difficult to read in bright light environments such as in bright sunlight and can contain very small fonts and graphics that are difficult to read and select.

Some conventional touchpads include vibratory feedback to the user of the touchpad. U.S. Pat. No. 5,977,867 is one example. Such conventional systems and methods are limited, though. They lack a full range of functionality assistance to a user interacting with an electronic device. Moreover, such systems and methods still require considerable visual attention from the user.

SUMMARY

The present invention comprises products and processes for providing tactile sensations to input devices or electronic devices. Input devices include mechanical input devices (such as, for example, mechanical switches) and non-mechanical input devices (such as, for example, touchpads). Tactile feedback is provided by using an actuator or other means in communication with the input device or electronic device. A controller may be employed to receive signals from the input devices and to control the actuator. Tactile feedback to an input device or electronic device may be provided in response to one or more events or situations. Such an event or situation may be any one designated. Examples of such events and situations include the level of pressure placed on an input device; the availability or lack of availability of a function associated with an input device; and the function, menu, or mode of operation associated with an input device's activation. A variety of feedback types and combinations may be selected. Mobile telephones and PDAs benefit from employing such products and processes, but other devices benefit as well. The advantages offered by the various embodiments of the present invention may be understood by examining this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an embodiment of an apparatus according to the present invention;

FIG. 2 is a plan view of another embodiment of an apparatus according to the present invention;

FIG. 3 is a plan view of an electronic device including an embodiment of the present invention;

FIG. 4 is a schematic representations through line 4-4 of FIG. 3;

FIG. 5 is a plan view of another electronic device including another embodiment of the present invention;

FIG. 6 is a schematic representations through line 6-6 of FIG. 5;

FIG. 7 is a block diagram illustrating an embodiment of the apparatus in an electronic device;

FIG. 8 is a flow chart illustrating a method according to the present invention;